LA-UR-80-1710

CONF-800824--2

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SUBMITTED TO: Fifth International Symposium on Polarization Phenomena in Nuclear Physics, Santa Fe, NM, August 11-15, 1980

MASTER

University of California

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St. No. 2629
12/78

UNITED STATES
DEPARTMENT OF ENERGY
CONTRACT W-7405-ENG-36

A POLARIZED NEUTRON BEAM AT LAMPF*

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ABSTRACT

We have measured the polarization of neutrons produced from the reaction pd $\rightarrow$n at a laboratory angle of 20^{o} at an incident proton kinetic energy of 800 MeV. For the highest energy neutron peak at ~665 MeV, as well as for the broad pion production peak at ~ 325 MeV, the neutron polarization has been found to be ~ 0.20. The measured polarization for the quasielastic process has been found to be in good agreement with the free np analyzing power measurements. Such a polarized neutron beam, having a broad spectrum of momenta from 800 to 1300 MeV/c has been used at LAMPF for free np spin correlation measurements.

One of the major objectives of our nucleon-nucleon work at LAMPF has been the determination of an unambiguous set of phase shifts for n-p scattering near 650 MeV. Free np spin polarization and correlation data are essential for the achievement of this objective. In order to measure the free np spin correlation parameter A_{nn}, for which no data exist in the published literature for the energy range 100-800 MeV, we have developed a polarized neutron beam with a broad spectrum of momenta from 800-1300 MeV/c. By scattering this beam of polarized neutrons from a polarized proton target we have measured $A_{np}(\theta)$ for 300-665 MeV for free np scattering.[1] Additionally, from this experiment we have also been able to extract high precision data for $A(\theta)$ for 300-665 MeV for free np scattering. These analyzing power data, in addition to providing an independent check, have extended the angular range of our previous measurements to 166^{o} cm. Preliminary $A(\theta,T_n)$ data from this experiment together with the results from our earlier measurements[2] where we used an unpolarized neutron beam, are being reported separately at this conference[3].

The 800 MeV proton beam after passing through a liquid deuterium (LD_2) target is transported to a beam dump several meters away. Neutrons produced at 20^{o} pass through a steel collimator with an exit diameter of 5cm. This collimated neutron

*Work performed under the auspices of the U.S. Department of Energy.

beam passes through two transverse field spin precession magnets, M1, and M2, each 2m long. The polarity of the first of these two magnets was kept fixed; reversing the polarity of the second therefore gave either no spin precession (M2=-M1) or 180° spin precession for 665 MeV neutrons (M2=M1).

The collimated neutron beam having a broad spectrum of momenta was scattered by a CH_2 target. Recoiling protons were detected with a multiwire proportional chamber spectrometer set at $\theta_L = 30^\circ$, which corresponds to ~110° cm for n-p scattering. The general characteristics of this spectrometer system have been previously described[4]. The choice of this angle setting for the spectrometer is based on our previous measurements[2] of the analyzing power, $A(\vec{np})$, where we found that it goes through a maxima near this setting. The equivalence of $A(\vec{np})$ and $A(\vec{np})$ is assumed for the purpose of converting the measured asymmetry into the neutron beam polarization. With this spectrometer we determined the direction and momentum of the scattered protons. Unambiguous particle identification was accomplished by a simultaneous measurement of time of flight through the spectrometer. An array of neutron counters was used to determine the direction of the corresponding outgoing neutron and its velocity. We were thus able to select elastic np events. The proton momentum and angle, then, uniquely determines the momentum of the incident neutron. A typical neutron energy spectrum thus constructed, is shown in Fig. 1. The polarization of the neutron beam obtained from the measured assymmetry is shown in Fig. 2. The polarization value of -0.20 for 665 MeV neutrons from the reaction $\vec{pd} \rightarrow npp$ at 20° lab. (which corresponds to a quasi elastic pn reaction at ~133° c.m.[3]) is in good agreement with the results of our free np measurements[3] where we found that for 775 MeV at 133° c.m.

$$A(\vec{np}) = -0.211 \pm 0.009.$$

In conclusion, the polarized neutron beam obtained from the $\vec{pd} \rightarrow \vec{n}$ reaction at $\theta_L = 20^\circ$[3] at 800 MeV has been used for good quality free np spin measurements[1,3].

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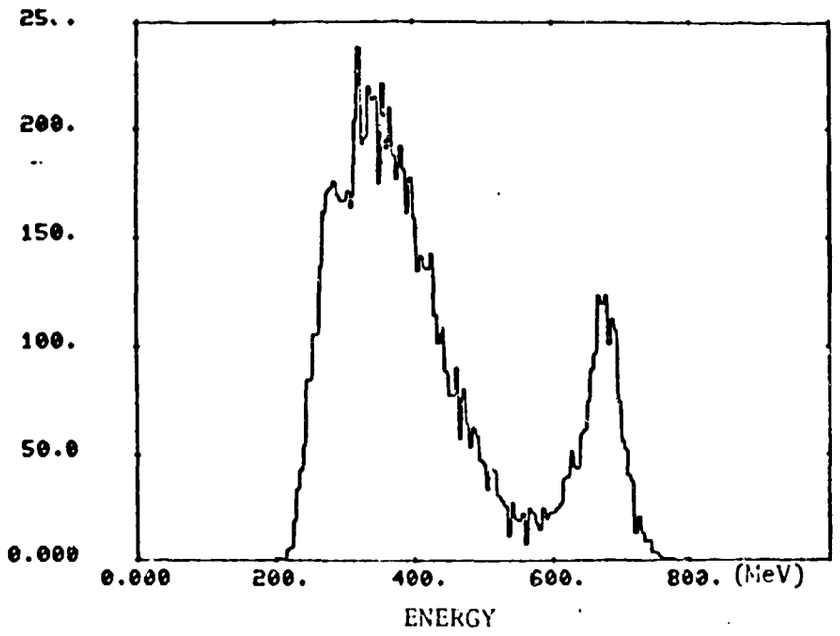

Figure 1. The neutron energy spectrum obtained from the measurement of direction and momentum of the recoiling proton from free np elastic scattering at 110° c.m.

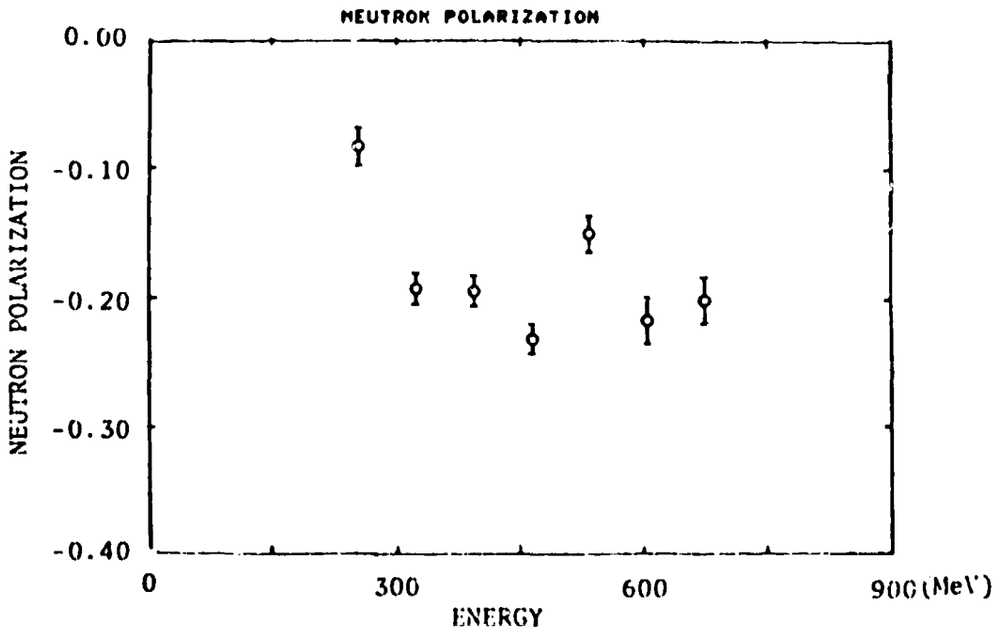

Figure 2. The polarization of neutrons vs. incident energy.